



Understanding the dynamic of government expenditures for disability and other social benefits: evidence from a Lotka–Volterra model for the Netherlands

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Abstract

In the Netherlands, access to disability insurance has become gradually more limited and demanding. The same holds for sheltered work. This puts disabled workers, and especially those with no working history, in disadvantaged competition with the non-disabled segment of the working population. In this study, we employ a Lotka–Volterra competition model based on differential equations to investigate how government expenditures for disability and other social benefits interacted in the period between 2010 and 2018. We contribute to the literature by showing that public expenditure for disability is not autonomous and that its competitive power in the social protection ecosystem changes both in type and over time. Our findings suggest that government expenditure for disability benefits in the Netherlands behaved both as prey in favour and predator at the cost of social exclusion and unemployment benefits. Reforms that took place in the ecosystem of interest are used to interpret such behaviour.

Keywords Differential equations · Disability · Government expenditure · Lotka–Volterra · Netherlands · Public policy

JEL Classification I30 · J14 · J48

1 Introduction

The assistance of social work companies is crucial for the sheltering of disabled people from the more extended working community, insofar this does not cause harms that require reparations afterwards (Steele and Swaffer 2022). Following the departure of Job Cohen, former leader of the Dutch Labour Party from his presidency at Cedris –the umbrella organisation of social work companies in the Netherlands, the politician expressed his

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concern that ‘social employment will collapse’. In this regard, the case study of disability is used in this research as a representative of the population of disabled people subject, on the one hand, to social benefits and, on the other, to an increasing mainstreaming of measures.

As regards the Dutch social work system, Cohen expressed his concern after the proposal by the Rutte II Cabinet was adopted. The proposal aimed to make bureaucratic procedures more efficient and the role of disabled workers in the labour market more participatory. It was adopted under the name of Participation Act by the House of Representatives on 20 February 2014 and officially passed in the Senate on 1 July 2014. This Act limited the access to disability insurance for people with no working history. While in the past they were entitled to a disability benefit, with the introduction of the Participation Act the disability insurance for people with no working history was only accessible for those who had no capacity to work. In general, other reforms –notably the Dutch Invalidity Insurance Act (WIA and WAO)– also limited access to disability insurance and increased the demands on disabled people and their employers. As described in Kantarci et al. (2019), to encourage work resumption, employers are forced ‘to compensate the employee for wage loss during the two years period of the sickness scheme’, which makes them ‘reluctant to hire workers with health problems’, including disability. In parallel, the number of disability benefits dropped and so did the amount of disability benefits received.

Access to and reward for sheltered work was also limited as the Participation Act was introduced. Since 1 January 2015, the Participation Act replaced the original Work and Social Assistance Act (WSW) for new entrants. Although the instruments of sheltered work or wage subsidies still exist in the Participation Act, the number of people entering sheltered work via the Participation Act is very low. The fact that a low number of subjects entered the labour market ‘regularly’ goes against the initial objective of the Participation Act, which was to guarantee equal access to work to everyone, including disabled people –implying disabled people would now be legally required to partake in the standard labour market¹ and ‘preferably with a mainstream employer’ (Sadiraj et al. 2018). This objective was stimulated by an agreement between the social partners and the government, which obliged firms and public services to create jobs for 125.000 disabled workers by 2026. A quota would be put into place if the number was not met.

There are also a number of reasons why, in the ordinary and non-mainstreaming-based system of government expenditure, disability benefits already compete with other social benefits. This is particularly true given the occupational and health effects that financial subsidies or benefits conditionality have on disabled people’s likelihood to enter the labour market (Koning and Van Sonsbeek 2017; Schreiner 2019; Geiger 2021; Jensen et al. 2019), as well as the competitive implications of budget cuts on unemployed and disabled people (Reeves et al. 2013). Contrarily to passive measures, the active integration of disabled people in sheltered work centres makes the constraining characteristics of the workplace, tasks, and schedule disappear through *ad hoc* training and measures of inclusion (Miralles et al. 2007; van der Torre and Fenger 2014). This is important for disabled people as employers may favour non-disabled individuals due to previous hiring behaviour (Hemphill and Kulik 2016) or stereotypes towards holders of severe disability. When mainstreaming policies such as the Participation Act are introduced, the competitive disadvantage of disabled people may even be larger as they neutralize positive action in favour of the categories they aim to protect in the first place (Stratigaki 2005).

¹ Please see: <https://business.gov.nl/regulation/participation-act/>.

In this article, we employ a Lotka–Volterra model based on differential equations to Dutch data from 2010 to 2018 with the aim of shedding light on the evolving role of disability within the social protection ecosystem of the Netherlands. As retrieved from Focacci (2023), ‘in animal ecosystems, relationships between certain species appear to be immutable (e.g. the lion is expected to always eat the antelope). However, over time, due to internal and external factors, such relationships may experience a change (e.g., a drought may cause antelopes to die out, with lions having to find an alternative source of nourishment)’. Similar interactions can be identified in the ecosystem of social expenditures, or ‘species’, which may decrease or increase as the result of changes in other expenditures part of the same system (Teisman et al. 2009). We contribute to the literature by using an innovative empirical approach that is mathematically reliable, easily replicable for other countries, and cheap data-wise. On this subject, the originality of the article also relies in the simultaneous analysis of government expenditures for different social benefits with a specific focus on disability, nowadays challenged by mainstreaming policies. In particular, our findings suggest that, in the period of investigation, government expenditure for disability benefits in the Netherlands behaved both as prey in favour and predator at the cost of social exclusion and unemployment benefits. This shows that public expenditure for disability is not autonomous and that its role in the social protection ecosystem changes both in type and over time in parallel with the introduction of policies that may disrupt or maintain the original state of the ecosystem.

2 Data and methods

In order to carry out our analysis, we collect yearly data from Eurostat on government expenditure between 2010 and 2018 on disability, unemployment, and social exclusion benefits. The use of aggregate data and to this particular period was justified by the availability of aggregate comparable data in this specific time period, and the lack of complete micro-level data on disabled persons. Hereinafter, we refer to these government expenditures as ‘species’. Data refer to the gross social protection expenditure in the Netherlands and are expressed in millions of Euros. Government expenditure data for benefits of social protection are collected by Eurostat in a way that guarantees mutual exclusiveness.

Particularly, benefits for disability are defined as ‘income maintenance and support in cash or kind (except health care) in connection with the inability of physically or mentally disabled people to engage in economic and social activities’. This includes WIA (WGA return-to-work benefit and IVA full-invalidity benefit), Wajong (incapacity-to-work benefit), former WAO incapacity benefits and WSW for social employment, and rehabilitation services by Dutch insurance provider UWV (Uitvoeringsinstituut Werknemersverzekeringen). The characteristics and severity of disability may vary. While we acknowledge that disability populations are not homogeneous, we account for the most inclusive definition of disability; namely, ‘people facing barriers to participation, owing to a long-standing health problem and/or a basic activity difficulty’ (Eurostat).

Social exclusion benefits are ‘benefits in cash or kind (except health care) specifically intended to combat social exclusion where they are not covered by one of the other functions’. As explained by Eurostat, this excludes small-scale, informal and incidental types of support that do not require regular management, as well as those benefits that cover needs clearly identifiable with a targeted category (e.g., the elderly, the disabled, the unemployed

and so on). Often, individuals who are subject to social exclusion experienced risk of poverty, severe material and social deprivation, or very low work intensity.

Finally, we account for ‘income maintenance and support in cash or kind in connection with unemployment’ for unemployment benefits.

Data are analysed through a non-autonomous Lotka–Volterra model, which is increasingly used by social scientists in various domains of social policy. Marasco and Romano (2018) used it to identify inter-generational conflict among American age cohorts, while Dominioni et al. (2020) applied a Lotka–Volterra model to highlight trust spillovers among European institutions. Focacci (2023) recently employed it to look at competitive relationships between government expenditures corresponding to the young and old segments of the Austrian, German, and Swiss populations.

The advantages of using this model were recently illustrated by Focacci and Quintavalla (2020). First, the model is able to detain any type of interaction occurring in a context where a change in a factor related to one category (e.g. expenditure in social exclusion benefits) affects other categories (e.g. expenditure in disability benefits) with which it is interacting. Second, the method exploits a deterministic model based on differential equations. This means that, being the interaction coefficients time-dependent, the model is capable of capturing essential structural changes occurred in a specific point in time—in other words, the interaction coefficient observed at a point in time t_1 is different from an interaction coefficient observed at a point in time t_2 , when another policy, economic shock, institutional crisis may have taken place. This is particularly useful knowing that contextual factors may influence government expenditure for social benefits. On this subject, the extant literature shows that exogenous factors such as the rising number of disabled people, economic shocks, or GDP growth can significantly impact the government expenditure among different social benefits, and hence explain their change over time. Third, the model does not require for the species to be isolated into pairs. On the contrary, it is able to analyse the simultaneous interactions among the three species considered. This is fundamental as different government expenditures coexist with each other and are a scarce resource. Fourth, ‘because the solutions of the model are known we do not have to estimate the parameters using expensive numerical methods; in other words, this empirical strategy is not data demanding’. This is useful for other data scientists when large micro-data sets are unavailable: the Lotka–Volterra model allows to identify the roles played by the different species—in our case, government expenditure for social benefits—directly from the data at hand (Focacci and Quintavalla 2020).

As explained above, applying this model allows to look at whether and how different ‘species’—in our case, expenditures for social benefits—interact with each other over time based on logistic estimates. While correlations indicate the extent to which two entities are related to each other, the Lotka–Volterra model estimates derivative coefficients that explain how much the decrease or increase of power of a certain species is due to the contemporary existence of another species. As explained in Yang et al. (2018), ‘previously, the causality of such autonomous differential equation models was understood only in mathematical terms because there was no prediction-based causal factor’. The authors, however, show that ‘causal influence of this model can be indeed established through the decomposition of instantaneous phase dependency’.

The long-term analysis on which the model is based allows to identify changes in the role played by government expenditure for disability benefits. In this model, the interaction coefficients are non-autonomous, in the sense that they are dependant on time, and the solutions of the model are known. The share of each species (ES) is defined in the form of a logit model. We focus particularly on three species; namely, $i = 1$ intended as the amount

spent by each government for disability benefits; $i = 2$ the amount spent for unemployment benefits; $i = 3$ the amount spent for social exclusion benefits. The shares of the i th species and of the outside source are defined as follows:

$$\begin{aligned} x_i(t) &= \frac{\exp(f_i(t))}{1 + \sum_{j=1}^3 \exp(f_j(t))}, \quad i = 1, 2, 3 \\ x_0(t) &= \frac{1}{1 + \sum_{j=1}^3 \exp(f_j(t))}, \quad \forall t \geq t_0, \end{aligned} \tag{1}$$

where the *utility function* of each species $f_i(t), i = 1, \dots, 3$, is equal to:

$$f_i(t) = \ln \left(\frac{TS_i(t)}{TS_0(t)} \right), \quad i = 1, 2, 3 \tag{2}$$

If the utility functions $f_i(t)$ are of class $C^2([t_0, +\infty))$, Eqs.(1)₁ are the unique global solution of the Cauchy problem:

$$\begin{cases} \dot{x}_i(t) = g_i(t)x_i(t)[1 - x_i(t)] - \sum_{j=1, j \neq i}^3 g_j(t)x_j(t)x_i(t), & i = 1, 2, 3 \\ x_i(t_0) = \frac{\exp(f_i(t_0))}{1 + \sum_{j=1}^N \exp(f_j(t_0))} \end{cases} \quad t \in [t_0, +\infty), \tag{3}$$

where $\dot{x}_i(t) = dx_i(t)/dt, x_0(t) = 1 - \sum_{i=1}^3 x_i(t)$, and

$$g_i(t) = \dot{f}_i(t) = \frac{\dot{TS}_i(t)}{TS_i(t)} - \frac{\dot{TS}_0(t)}{TS_0(t)}, \quad i = 1, 2, 3 \tag{4}$$

The model we present illustrates the interaction between the i th and j th species (Table 1). The share of the species depends on the logistic growth rate $g_i(t)$ and the interaction functions $g_j(t)$ between the i th and j th species. The maximum capacity of each species is equal to 1 and the type of relationship that occurs among species depends on the sign of the functions $g_i(t)$ and $g_j(t)$. The utility functions $f_i(t)$ are the nonlinear combination of variables $V_h, h = 1, \dots, M$, which depend on time. The share of the i th species grows when its utility function $f_i(t)$ increases in value, whereas it decreases when the value of the utility function $f_j(t)$ of another species increases. Thus, Eq. (3) indicates how changes in the utility functions of one species affect the shares of the other species.

It is important to note that the data is based on shares, as we cannot observe the utility functions. Consequently, we identify the utility functions using a standard fitting procedure (Fourier).

By using a deterministic model for our analysis, we are able to explore how the interactions among the four species of interest—namely, disability, unemployment, and social exclusion benefits—have simultaneously evolved over time. Additionally, as the solutions of the model are known, we can carry out the analysis even if the number of observations is relatively limited.

To assess the accuracy of the model, we calculate the Mean Absolute Percentage Error (MAPE), following Lewis (1982). In particular, we define our model as highly accurate when $MAPE < 10\%$; good if $10\% < MAPE < 20\%$; reasonable when $20\% < MAPE < 50\%$; and inaccurate if $MAPE > 50\%$.

Table 1 Possible interactions among species

g_i	g_j	Interaction	Definition
+	+	Competition	An \uparrow (\downarrow) in the value of one index negatively (positively) affects the value of the other index
-	+	Predator–Prey	An \uparrow (\downarrow) in the value of index A negatively (positively) affects the value of index B (prey). An \uparrow (\downarrow) in the value of index B positively (negatively) affects index A (predator)
-	-	Mutualism	An \uparrow (\downarrow) in the value of one index increases (reduces) the value of the other
-	0	Commensalism	An \uparrow (\downarrow) in the value of index A positively (negatively) affects index B. Index A is unaffected by changes in B
+	0	Amensalism	An \uparrow (\downarrow) in the value of index A negatively (positively) affects index B. Index A is unaffected by changes in B
0	0	Neutralism	No interaction

Table 2 Descriptive statistics for government expenditure in the Netherlands

Social benefit	Min	Max	Mean	SD
Disability	14740	19367	16602	2078.4
Unemployment	7396	10704	9117.3	1171.6
Social Exclusion	8006	10780	9379.2	939.2

Table 3 MAPE for the four species considered

Disability	Unemployment	Social exclusion
2.61362	1.49112	3.34884

Table 4 Role of disability benefits expenditure relative to other benefits by approximate time intervals

	Unemployment	Social	Exclusion
2010–2011	Mutualism	2010–2012	Prey
2011–2013	Prey	2012–2013	Mutualism
2013–2014	Competitor	2013–2015	Predator
2014–2017	Predator	2015–2017	Competitor
2017–2018	Mutualism	2017–2018	Prey

Our Mean Absolute Percentage Errors are calculated as in:

$$MAPE = \frac{1}{n} \sum_{i=1}^n \left| \frac{h_i - p_i}{h_i} \right| 100\%, \tag{5}$$

where h_i and p_i are, respectively, the historical and predicted values.

With respect to the data used, we observe that, in this period, the government in the Netherlands spent the most in disability benefits, for which public spending reached a minimum and maximum of, respectively, 14,740 and 19,367 million Euros between 2010 and 2018. Regarding unemployment and social exclusion, government expenditure was equal to 9,117,33 and 9,379,22 on average in the period under investigation (Table 2).

With regards to the accuracy of the model, we find very low values for the Mean Absolute Percentage Error, indicating that the fitting procedure used in this analysis was highly accurate. Namely, the MAPE is equal to 2.61362, 1.49112, and 3.34884 for, respectively, government expenditure in disability, unemployment, social exclusion (Table 3).

3 Results and discussion

In the following sections, we look at how government expenditures for social benefits have evolved and interacted over time in the Netherlands in the period between 2010 and 2018. Particularly, we use the Lotka–Volterra model to explore the interactions of both disability (in blue) and unemployment (in red); and disability and social exclusion (in black). The

Fig. 1 Interaction Coefficients for the Netherlands on Disability (blue) and Unemployment (red) between 2010 and 2018. (Color figure online)

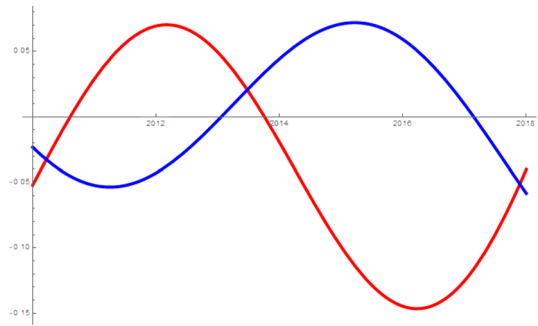
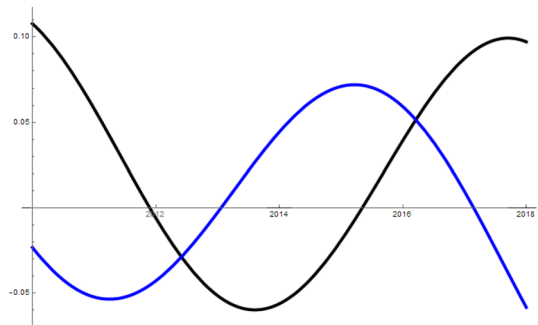


Fig. 2 Interaction Coefficients for the Netherlands on Disability (blue) and Social Exclusion (black) between 2010 and 2018. (Color figure online)



relationships are summarised in the Table 4 below and illustrated in the Figs. 1 and 2, which give a complete overview of the changes from one type of relationship to the other.²

As can be observed from Fig. 1, between 2010 and 2011 public spending for unemployment benefits and public spending for disability benefits were in a relationship of mutualism, meaning that one species created spillover effects in the same direction for the other species. If government expenditure for disability benefits increased (decreased), so did government expenditure for unemployment benefits, and vice versa. In the two years later, government expenditure for disability benefits acted as a prey: an increase in public spending for unemployment benefits negatively affected public spending for disability. Between 2013 and 2014, public spending for unemployment benefits and public spending for disability benefits were in a relationship of competition. This time, the relationship implied opposite interaction in the growth of one species over the other: when public spending for one species increased, public spending for the other species decreased. In 2014–2016, disability and unemployment benefits experienced a predator–prey relationship in favour of disability: the increase in public spending for the disabled negatively affected public spending for unemployment. In the last period under investigation, the two species went back to a relationship of mutualism, showing that relationships may change in an ecosystem or go back to their original state. Due to the aggregate nature of the available data, we do not account for specific disabilities and their relationship to unemployment, but rather provide an overview of the relationship between the species of government expenditure for disability and for unemployment.

² Note that changes in the type of relationship between two species are never sudden.

The relationship between government expenditure for disability and social exclusion shows a more prominent presence of competitive types of relationship over time (Fig. 2). Between 2010 and 2012, disability benefits played the role of prey for social exclusion benefits, meaning that an increase in public spending for disabled people positively affected public spending for social exclusion. Between 2011 and 2012, the relationship transformed into mutualism: the increase or decrease of government spending for one species did not threaten government spending for the other. In the period of 2013–15, public spending for disability acquired the role of predator: an increase in government expenditure for disability negatively affected government expenditure for social exclusion. The relationship, however, quickly changed to competition between 2015 and 2017, when an increase (decrease) in public spending for one species negatively (positively) affected the other. Public spending for disability went back to its role of prey in 2017–18.

3.1 Discussion

As can be observed from the results, our Lotka–Volterra model established different types of relationships between social benefits in the period under investigation. The model clearly identifies pure interactions between species but cannot account for delayed effects of policies. The purpose of this paper is not to attribute effects to particular reforms implemented in the Netherlands over time. However, we speculate on the hypothetical influence that some of the policies may have had with respect to shaping certain interactions observed in the Lotka–Volterra model. Relationships are illustrated chronologically for convenience.

As regards the relationship between government expenditure for disability and unemployment benefits, over the years, the (re-)examination of disabled people's condition for entitlement to disability benefits has become more demanding (Van Sonsbeek and Gradus 2013). As a result, access to disability insurance has become more limited and a substantial outflow of disabled people from disability benefits has been registered. Thus, in 2010, disability benefit recipients in the Netherlands were equal to only 10.6% of the working population –compared to 14.5% in 1990 (van Berkel 2013). In parallel, between 2008 and 2010, the consequences brought by the economic and financial crisis led to a staggering number of unemployed people and firms in crisis. Looking at our results, this seems to suggest that, in the context of shocks –in 2009, the GDP annual growth was negative and equal to – 3.7– disability benefits cannot assume a predominant position in the social protection hierarchy. If anything, stricter eligibility requirements contributed to the development of mutualism or roles of prey, as was the case for 2010–2012.

In 2013, trade unions, employers, and the government collectively decided that 125,000 additional jobs should be created for disabled people unable to obtain the minimum wage by themselves.³ Employers hiring disabled workers would obtain the so-called *loonkosten-subsidie*; namely, a wage subsidy for the potential loss in productivity the disabled worker would cause to the firm. According to the 2015 Participation Act scheme, today disabled workers are only paid for their actual productivity, while the supplementary benefit they might be entitled to is provided at the social assistance level by their municipality (Oostveenm 2018). In practical terms, abandoning the *loonkostensubsidie* means that disabled people are unable to abandon their benefit dependency in favour of non-sheltered jobs. As a result, the chances for disabled workers to find employment decreased from 50% in 2012,

³ For more details, please see the ESPN Flash Report 2018/39.

when sheltered work was still an option, to 30% at the end of 2015; while in 2016, ‘47% for persons with a chronic illness, 64% for persons with a physical disability and 78% for persons with a severe psycho-social disability’ did not have paid work.⁴

With less occupationally active disabled people and the progressive disappearance of sheltered work, social assistance rose to significant levels, burdening Dutch municipalities. In parallel, the unemployment rate decreased everywhere in the country, from 6.9% in 2015 to 4.9% in 2017, emphasizing the relative worsening of the position of disabled individuals in the labor market. In line with the progressive outflow in disability benefits consequent to limitation of access to and income from sheltered employment, disability benefits still acted as predators in 2016, suggesting that when policy spending for disability decreases this may create increases in other species, including unemployment benefits. Later evaluations by the Dutch Sociaal en Cultureel Planbureau’s (SCP) also suggest that, together with the relative success of the new *banenafspraak* (job agreements), the initial decline of activation measures directed at disabled people by municipalities have improved in the last years, confirming the positive but lagged effects of policies.

In parallel to the progressive outflow in disability benefits consequent to the stricter eligibility requirements posed by the government, more attention was dedicated to social exclusion in the Netherlands in the first decade of the 2000s. 2010 was, for instance, designated by the European Commission as the Year for Combating Poverty and Social Exclusion. On this occasion, former foreign affairs minister Frans Timmermans stressed the worrying increasing levels in social isolation for individuals who ‘still feel excluded as a result of bullying at school, homophobia or racial or religious discrimination’.⁵

While the 2013 Social Agreement introduced numerous measures, including the wage cost subsidy in favour of the disabled segment, the 2015 Participation Act ended up leaving many disabled people not just out of work—as ‘procedures and regulations to get disabled persons in adjusted jobs [became] too complex’ (Knijn and Hiah 2019)—but also subordinate to costly social assistance due to their exclusion from the labour market. In other words, expenditure for social exclusion benefits now also included costs that were formerly denominated exclusively as disability costs.⁶ At the same time, in 2015 and 2016, the Dutch government launched a series of anti-discrimination campaigns focused on the recruitment of new workers, the Convention on the Rights of the Child, as well as the safeguarding of democracy and the prevention of violent extremism. The first Convention on the Rights of Persons with Disabilities also took place in 2016, to help disabled people live independently, afford rental houses in their preferred municipality, participate in cultural life and sports, and avoid social exclusion.

In this period, measures for social exclusion dominated both national and international debates. In parallel, it was a marginalising period for other social benefits, including disability. Based on this, one might speculate that activation policies that encourage public

⁴ Data are taken from the December 2018 Report by the Netherlands Institute for Human Rights.

⁵ Please see a report by the Dutch government on this subject at: <https://www.government.nl/latest/news/2010/01/20/2010-european-year-for-combating-poverty-and-social-exclusion>.

⁶ Based on Dutch StatLine data (CBS) and Sociaal en Cultureel Planbureau’s (SCP) Eindevaluatie van de Participatiewet, we estimate that the proportion of social exclusion expenditure actually dedicated to people who are disabled and dependent on the Participation Act has increased from 2.4% in 2015 to 3.0% in 2016, 4.3% in 2017, and 4.8% in 2018. In parallel, government expenditure for disability since the Participation Act of 2015 has progressively decreased over time –by 1.2% in 2015, 1.6% in 2016, 2.3% in 2017, and 2.5% in 2018.

spending for social exclusion can contribute to the latter taking on a dominant role towards disability either as a competitor or as predator.

Limiting access to sheltered work in favour of regular work in the standard labour market forced disabled individuals out of the labour market. This, then, contributed to increasing their rate of unemployment, burdening Dutch municipalities as regards both unemployment and disability benefits. At the same time, government expenditure for disability policies failed to achieve its goal of including disabled people in the more extended working society and institutions of social exclusion were forced to take over.

While social benefits may be independent categories in theory, in practice their boundaries are not always well defined. The Lotka–Volterra model illustrates this clearly. Different relationships between species, or government expenditures, can be observed in the Netherlands. More detailed and long-term data would allow to account for potential lagging effects.

4 Conclusions

In this analysis, we employed a Lotka–Volterra model on Dutch data between 2010 and 2018 to understand the relationships between disability benefits and other benefits of interest to vulnerable categories, including unemployment and social exclusion benefits. By identifying time-dependent interactions between species that exist simultaneously, the Lotka–Volterra model shows that public expenditure for disability is not autonomous and that its competitive power in the social protection ecosystem changes both in type and over time. Particularly, our findings suggest that government expenditure for disability benefits in the Netherlands behaved both as prey in favour and predator at the cost of social exclusion and unemployment benefits in the period of investigation.

Studying the effect that each species has on another species by taking into account the effect that said species has on itself is an innovative approach that adds value to the analysis of systems such as governance. In particular, it allows to better understand the non-independence of different types of government expenditures in a given country and to do so rigorously on limited data. While the aim of the paper was to qualify relationships and show that ecosystems are always dynamic, future research may extend such model to other neighbouring countries, or identify micro-level effects specifically derived from policy making. This is especially useful for ecosystems that want to apply a holistic synergistic approach to government expenditure, something able to prevent unintended and, sometimes negative, consequences for specific categories of the population.

On this subject, further research designs, based on longitudinal micro data and interviews, may address the extent to which policy makers are actively conscious about interactions between species in the domain of social benefits and if so, whether or not they anticipate and respond to such perceived interactions. In the context of disability reforms, interaction models like the Lotka–Volterra model may be used to study the extent to which relationships between disability and unemployment and social exclusion change based on the severity of the disability. The interpretation of our findings may be further studied by looking at the incentives and eligibility criteria that benefit recipients face due to policy reforms. Finally, the model can also be used to investigate time-specific crises. This is especially true as regards the pandemic period, which significantly affected the disabled population (Genova et al. 2023) and reinterpreted the role of social enterprises in facilitating their integration in the labour market (Chui et al. 2023).

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Declarations

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